Part I

BIOFUELS: PROSPECTS, RISKS AND OPPORTUNITIES

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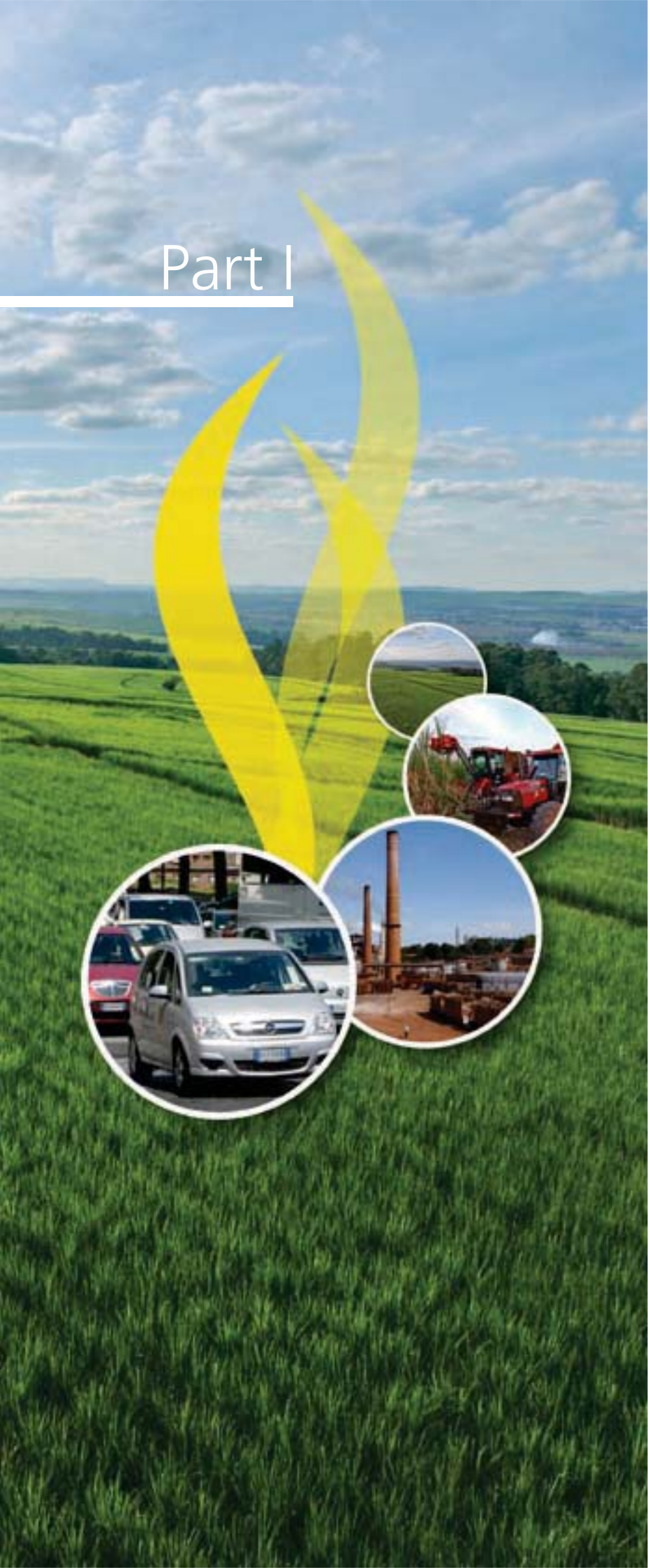


1. Introduction and key messages

When the initial preparations for the 2008 issue of *The State of Food and Agriculture* began, two years ago, there were high expectations surrounding liquid biofuels as a resource that could potentially mitigate global climate change, contribute to energy security and support agricultural producers around the world. Many governments cited these goals as justification for implementing policies promoting the production and use of liquid biofuels based on agricultural commodities.

Since then, there has been a marked change in perceptions of biofuels. Recent analysis has raised serious questions regarding the full environmental impacts of producing biofuels from an already stressed agricultural resource base. The costs of policies aimed at promoting liquid biofuels – and their possible unintended consequences – are beginning to attract scrutiny. Food prices have risen rapidly, sparking protests in many countries and giving rise to major concerns over the food security of the world's most vulnerable people.

However, biofuels are only one of many factors that have driven the recent rise in commodity prices. Also, biofuels have other implications beyond their effect on commodity prices. This issue of *The State of Food and Agriculture* surveys the current state of the debate on biofuels and explores these implications. It examines the policies being implemented in support of biofuels and the policies that would be needed to address their implications for the environment, food security and the poor.

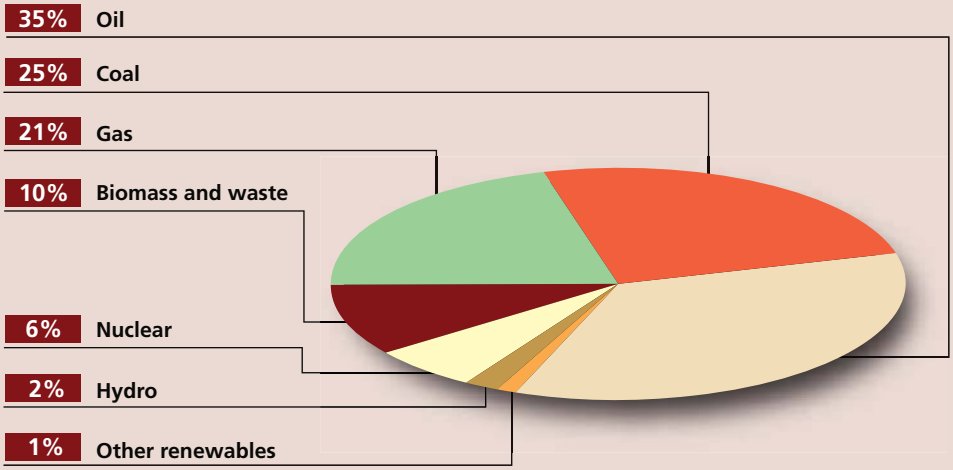
Agriculture and energy

Agriculture and energy have always been tied by close links, but the nature and strength of the relationship have changed over time. Agriculture has always been a source of energy, and energy is a major input in modern agricultural production. Until the nineteenth century, animals provided almost all the "horse power" used for transport and farm equipment, and in many parts of the world they still do. Agriculture produces the "fuel" to feed these animals; two centuries ago, around 20 percent of the agricultural area in the United States of America was used to feed draught animals (Sexton *et al.*, 2007).

The linkages between agriculture and energy output markets weakened in the twentieth century as fossil fuels gained prominence in the transport sector. At the same time, linkages on the input side strengthened as agriculture became increasingly reliant on chemical fertilizers derived from fossil fuels and machinery powered by diesel. Food storage, processing and distribution, too, are often energy-intensive activities. Higher energy costs, therefore, have a direct and strong impact on agricultural production costs and food prices.

The recent emergence of liquid biofuels based on agricultural crops as transport fuels has reasserted the linkages between energy and agricultural output markets. Liquid biofuels have the potential to exert a significant effect on agricultural markets, but they are, and are likely to remain, a

FIGURE 1
World primary energy demand by source, 2005



Source: IEA, 2007.

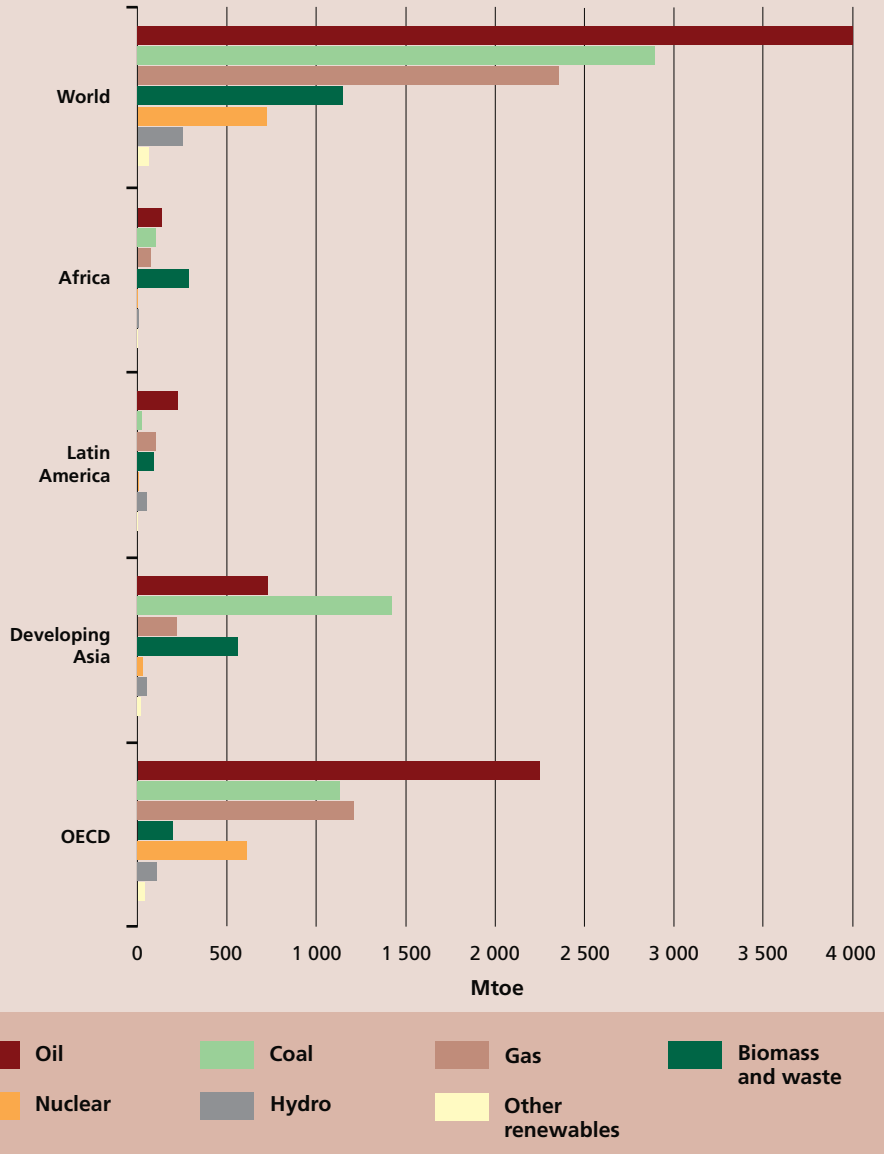
relatively small part of the overall energy market. The world's total primary energy demand amounts to about 11 400 million tonnes of oil equivalent (Mtoe) per year (IEA, 2007); biomass, including agricultural and forest products and organic wastes and residues, accounts for 10 percent of this total (Figure 1). Fossil fuels are by far the dominant source of primary energy in the world, with oil, coal and gas together supplying more than 80 percent of the total.

Renewable energy sources represent around 13 percent of total primary energy supply, with biomass dominating the renewable sector. The sources of primary energy differ markedly across regions (Figure 2). In some developing countries, as much as 90 percent of the total energy consumption is supplied by biomass. Solid biofuels such as fuelwood, charcoal and animal dung constitute by far the largest segment of the bioenergy sector, representing a full 99 percent of all biofuels. For millennia, humans have depended on the use of biomass for heating and cooking, and developing countries in Africa and Asia remain heavily dependent on these traditional uses of biomass. Liquid biofuels play a much more limited role in global energy supply and account for only 1.9 percent of total bioenergy. Their significance lies mainly in the transport sector, but even here they supplied only 0.9 percent of total transport fuel consumption in 2005, up from 0.4 percent in 1990.

In recent years, however, liquid biofuels have grown rapidly in terms of volume and of share of global demand for transport energy. The growth is projected to continue, as illustrated by Figure 3, which shows historical trends as well as projections to 2015 and 2030, as reported in the *World Energy Outlook 2007* (IEA, 2007).[1] Nevertheless, the contribution of liquid biofuels to transport energy and, even more so, to global energy use, will remain limited. Global primary energy demand is, and will remain, overwhelmingly dominated by fossil fuels – with coal, oil and gas currently accounting for 81 percent of the total. This share is forecast at 82 percent in 2030, with coal increasing its share at the expense of oil. Biomass and waste products currently cover 10 percent of global primary energy demand, a share that is forecast to decline slightly to 9 percent by 2030. By the same year, liquid

[1] The projection refers to the IEA's so-called "Reference Scenario", which "is designed to show the outcome, on given assumptions about economic growth, population, energy prices and technology, if nothing more is done by governments to change underlying energy trends". The projections and underlying assumptions are discussed in Chapter 4.

FIGURE 2
Total primary energy demand by source and region, 2005



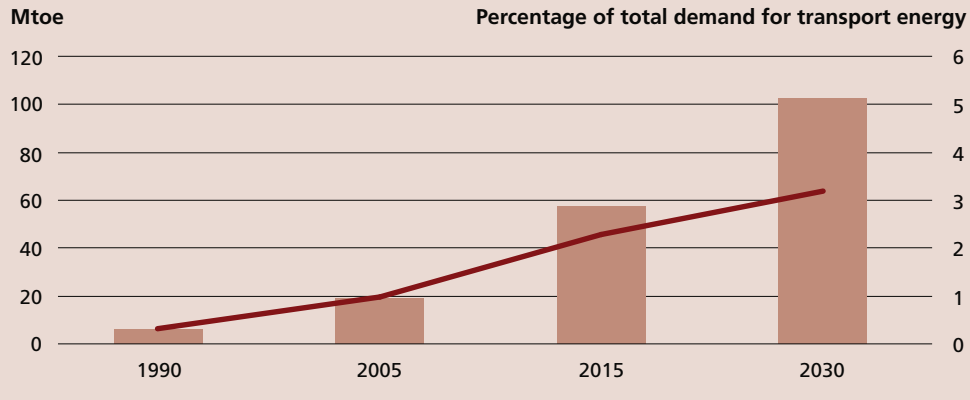
Source: IEA, 2007.

biofuels are projected to represent the still modest share of 3.0–3.5 percent of global transport energy consumption.

Opportunities and risks for liquid biofuels

Notwithstanding the limited importance of liquid biofuels in terms of global energy supply, also compared with that of solid biofuels, their direct and significant effects on global agricultural markets, on the environment and on food security are already generating debate and controversy. This new source of demand for agricultural commodities creates opportunities, but also risks, for the food and agriculture sectors. Indeed, the demand for biofuels could reverse the declining trend in real commodity prices that has depressed agricultural growth in much of the developing world over recent decades. As such, biofuels may offer an opportunity for developing countries –

FIGURE 3
Trends in consumption of transport biofuels



Source: IEA, 2007.

where 75 percent of the world's poor depend on agriculture for their livelihoods – to harness agricultural growth for broader rural development and poverty reduction.

A stronger link between agriculture and the demand for energy could result in higher agricultural prices, output and gross domestic product (GDP). The development of biofuels could also promote access to energy in rural areas, further supporting economic growth and long-term improvements in food security. At the same time, there is a risk that higher food prices could threaten the food security of the world's poorest people, many of whom spend more than half of their household incomes on food. Moreover, demand for biofuels could place additional pressure on the natural resource base, with potentially harmful environmental and social consequences, particularly for people who already lack access to energy, food, land and water.

Given current agronomic and conversion technologies, the economic viability of most liquid biofuels in many, but not all, countries is tenuous without support and subsidies. However, improved crop yields, area expansion and intensification could expand feedstock production significantly and reduce costs. Technological innovation in biofuel processing could also lower costs dramatically, potentially bringing second-generation biofuels derived from cellulosic feedstocks into commercial production, thereby reducing competition with agricultural crops and the pressure on commodity prices.

Biofuel policies and objectives: is there a mismatch?

Most recent growth in biofuel production has occurred in the Organisation for Economic Co-operation and Development (OECD) countries, predominantly the United States of America and the European Union (EU) countries. An exception is Brazil, which has pioneered the development of an economically competitive national biofuel sector based largely on sugar cane. In the OECD countries, biofuels have been promoted by policies supporting and subsidizing production and consumption; such policies are now being introduced in a number of developing countries.

The main drivers behind OECD country policies have been the objectives of energy security and climate-change mitigation through reduced greenhouse gas emissions combined with a desire to support agriculture and promote rural development. These concerns are not diminishing; indeed, climate change and future energy security continue to move higher up the international policy agenda. However, the role of biofuels

in addressing these concerns, including the appropriate policies to be applied, is now coming under closer scrutiny. Questions are being asked about the coherence of current policies and some of the underlying assumptions, and new concerns are coming to the forefront.

First of all, the policies being pursued are costly. Indeed, estimates of prevailing biofuel subsidies are high considering the still relatively limited role of biofuels in world energy supply. Estimates by the Global Subsidies Initiative for the EU, the United States of America and three other OECD countries (see Chapter 3) suggest a total level of support to biodiesel and ethanol in 2006 of around US$11–12 billion (Steenblik, 2007). On a per-litre basis, support ranges between US$0.20 and US$1.00. With increasing levels of biofuel production and support, costs could escalate. While it can be claimed that subsidies are only intended to be temporary, whether this will be the case will obviously hinge on the long-term economic viability of biofuels. This, in turn, will depend on the cost of other energy sources, whether they be fossil fuels or, in the longer term, alternative sources of renewable energy. Even taking into account recent rises in oil prices, among the major producers only Brazilian sugar-cane ethanol currently appears to be competitive with fossil fuel counterparts without subsidies.

Direct subsidies, however, represent only the most obvious cost; other hidden costs are the outcome of distorted resource allocation resulting from selective support to biofuels and quantitative tools such as blending mandates. For decades, agricultural subsidies and protectionism in numerous OECD countries have led to major misallocation of resources at the international level, with heavy costs both to consumers in the OECD countries and to developing countries. Such misallocation risks being perpetuated and exacerbated by current biofuel policies in OECD countries.

Another cost dimension, in addition to the total cost consideration, is linked to the effectiveness in reaching stated objectives. Biofuel policies are often justified on the basis of multiple, sometimes competing, objectives, and this lack of clarity can lead to policies that fail to achieve their objectives or do so only at very high costs. An example is the high cost of reducing greenhouse gas emissions through substitution of fossil energy with biofuels (Doornbosch and Steenblik, 2007). The cost-effectiveness of achieving emission reductions through biofuel development is increasingly questioned, especially if biofuel development is not integrated into a wider framework encompassing energy conservation, transport policies and the development of other forms of renewable energy.

Similarly, the technical efficiency of biofuels in contributing to reduced emissions is also coming under scrutiny, depending on the type of biofuel and its origin in terms of crop and location. Taking into account the complete production process for biofuels and possible land-use changes needed to expand feedstock production may critically alter the presumed favourable greenhouse gas balance sheet for biofuels. Indeed, recent research suggests that large-scale expansion of biofuel production could lead to net increases in greenhouse gas emissions.

Other environmental sustainability issues are also coming to the forefront. Although bioenergy can provide environmental gains, its production also has the potential to cause environmental damage. The impact of expanded biofuel production on land and water resources and on biodiversity is the focus of increasing attention, as is the question of how to ensure its environmental sustainability.

Biofuel policies have generally been designed within a national framework with little regard for unintended consequences at the national and international levels. As the implications of biofuel development for developing countries are scrutinized more closely, one emerging concern is the negative impact of high food prices – which are partly a result of increased competition from biofuels for agricultural output and resources – on poverty and food security.

At the same time, increasing demand for biofuels may offer opportunities for farmers and rural communities in developing countries and thus contribute to rural development. However, their capacity to take advantage of these opportunities depends on the existence of an enabling environment. At the global level, current trade policies – characterized by high degrees of support and protection – do not favour developing

country participation or an efficient international pattern of biofuel production. At the domestic level, farmers depend critically on the existence of an appropriate policy framework and the necessary physical and institutional infrastructure.

The report looks more closely at these issues in the light of the most recent emerging evidence.

Key messages of the report

- **Demand for agricultural feedstocks for liquid biofuels will be a significant factor for agricultural markets and for world agriculture over the next decade and perhaps beyond.** The demand for biofuel feedstocks may help reverse the long-term decline in real agricultural commodity prices, creating both opportunities and risks. All countries will face the impacts of liquid biofuel development – whether or not they participate directly in the sector – because all agricultural markets will be affected.
- **Rapidly growing demand for biofuel feedstocks has contributed to higher food prices, which pose an immediate threat to the food security of poor net food buyers (in value terms) in both urban and rural areas.** Many of the world's poor spend more than half of their household incomes on food, and even in rural areas the majority of the poor are net purchasers of food. Safety nets are urgently needed to protect the world's poorest and most vulnerable people and to ensure their access to adequate food. But safety nets should be carefully targeted and should not block the transmission of price signals to agricultural producers.
- **In the longer term, expanded demand and increased prices for agricultural commodities may represent opportunities for agricultural and rural development.** However, market opportunities cannot overcome existing social and institutional barriers to equitable growth – with exclusion factors such as gender, ethnicity and political powerlessness – and may even worsen them. Moreover, higher commodity prices alone are not enough; investments in productivity and sustainability-enhancing research, enabling institutions, infrastructure and sound policies are also urgently needed. A strong focus on the needs of the poorest and least resource-endowed population groups is crucial to ensure broad-based rural development.
- **The impact of biofuels on greenhouse gas emissions – one of the key motivations underlying support to the biofuel sector – differs according to feedstock, location, agricultural practice and conversion technology.** In many cases, the net effect is unfavourable. The largest impact is determined by land-use change – for example through deforestation – as agricultural area is expanded to meet growing demand for biofuel feedstocks. Several other possible negative environmental effects – on land and water resources, as well as on biodiversity – occur largely because of changes in land use. Accelerated biofuel production, pushed by policy support, strongly enhances the risk of large-scale land-use change and the associated environmental threats.
- **Harmonized approaches for assessing greenhouse gas balances and other environmental impacts of biofuel production are needed to achieve desirable outcomes.** Criteria for sustainable production can contribute to improving the environmental footprint of biofuels, but they must focus on global public goods and be based on internationally agreed standards and must not put developing countries at a competitive disadvantage. The same agricultural commodities should not be treated differently according to whether they are destined for biofuel production or for traditional uses such as human consumption or feed.
- **Liquid biofuels are likely to replace only a small share of global energy supplies and cannot alone eliminate our dependence on fossil fuels.** Land requirements for feedstock production would be too extensive to allow displacement of fossil fuels on a larger scale. The introduction of second-generation biofuels based on lignocellulosic feedstocks could

greatly expand potential, but for the foreseeable future liquid biofuels would still be able to supply only a small portion of global transport energy and an even smaller portion of total global energy.

- **Production of liquid biofuels in many countries is not currently economically viable without subsidies, given existing agricultural production and biofuel-processing technologies and recent relative prices of commodity feedstocks and crude oil.** The most significant exception is sugar-cane-based ethanol production in Brazil. Competitiveness varies widely according to the specific biofuel, feedstock and production location, and economic viability can change as countries face changing market prices for inputs and oil, as well as through technological advances in the industry itself. Technological innovation can lower the costs of agricultural production and biofuel processing. Investment in research and development is critical for the future of biofuels as an economically and environmentally sustainable source of renewable energy. This applies both to the field of agronomy and to conversion technologies. Research and development on second-generation technologies, in particular, could significantly enhance the future role of biofuels.
- **Policy interventions, especially in the form of subsidies and mandated blending of biofuels with fossil fuels, are driving the rush to liquid biofuels.** However, many of the measures being implemented by both developed and developing countries have high economic, social and environmental costs. The interactions among agricultural, biofuel and trade policies often discriminate against developing-country producers of biofuel feedstocks and compound impediments to the emergence of biofuel processing and exporting sectors in developing countries. There is a need to review current biofuel policies and carefully assess their costs and consequences.
- **Ensuring environmentally, economically and socially sustainable biofuel production requires policy action in the following broad areas:**
  - protecting the poor and food-insecure;
  - taking advantage of opportunities for agricultural and rural development;
  - ensuring environmental sustainability;
  - reviewing existing biofuel policies;
  - making the international system supportive of sustainable biofuel development.